

Internal Fixation Using Screw in Undisplaced Femoral Neck Fracture: Educational Corner

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Background

Femoral neck fracture is considered to be one of the most devastating and common injuries encountered by orthopedic surgeons. Over 150000 femoral neck fractures occur every year in the United States (US), and in accordance with aging of the population, this number will be doubled by the year 2050. This condition can be considered as a healthcare burden with notable socioeconomic impact worldwide (1-3). Regarding the Garden classification, type 1 and 2 are considered impacted or undisplaced femoral neck fracture (UFNF) (4). Although the treatment of displaced femoral neck fracture in the elderly is commonly defined as hip arthroplasty, the treatment for UFNF is still controversial (5, 6).

How to Make Sure the Fracture Is Undisplaced?

Among the various classification systems being used for fracture of the femoral neck, Garden classification is the most widely-used today. In this system, Garden I and Garden II consist of non-displaced fractures. Garden I is an incomplete fracture in which the line of fracture does not reach to the medial cortex and the head stays in relative valgus, while Garden II refers to all those complete but undisplaced fractures.

Regarding various guidelines, including National Institute of Health and Care Excellence guidelines, Australian and New Zealand Hip Fracture Registry (ANZHFR) guidelines, and American College of Radiology (ACR) Appropriateness Criteria, magnetic resonance imaging (MRI) is considered the gold standard for occult femoral neck fractures and computed tomography (CT) scan is used if MRI is not available or if it is contraindicated (7-9). MRI has shown a sensitivity approaching 100% for detecting these fractures with the ability of assessing other pelvic injuries (10), while CT scan has a sensitivity of 86% and specificity of 98% for occult hip fracture (11).

Management Options

Is There any Place for Non-Operative Management?:

Regarding the controversy about UFNF treatment, it should be noted that although Raaymakers and Marti (12) reported a 85.9% success rate for conservative treatment, Taha et al. (13) found that it succeeded in about only 44% of cases to achieve union, and others reported secondary

displacement rate of 33% and 41%, respectively (14, 15). Chen et al. (16) and Phillips and Christie (17) reported union rates more than 94% for the surgical option. In addition, Bentley (18), Manninger et al. (19), and Cserhati et al. (20) who had compared conservative with surgical treatments in UFNF recommended the surgical one. Reviewing the literature, it was recommended to manage these fractures surgically in the young population (21, 22). It is noted that in a recent systematic review on elderly population, it was also found that surgical treatment for UFNF was associated with a higher union rate and a tendency toward less avascular necrosis (AVN) in comparison with conservative treatment (23). Thus, in conclusion, there is no tight recommendation on non-operative management of UFNF.

Surgical Management

What Is the Best Device for Internal Fixation?: Internal fixation for UFNF is the treatment of choice in young patients whenever possible. This may be because of favoring hip preservation, and considering that the young healthy patients often have good bone density, this method can result in a durable stability (21, 22). The higher rate of osteoporosis, long-term potential complications including AVN, implant failure, or nonunion are considered to be disadvantages of internal fixation in the elderly population (24, 25). On the other hand, minimally-invasive nature of internal fixation leads to a lower rate of early post-operative complications, shortened hospital stay, and less reported mortality rate (24, 26, 27). A recent systematic review showed that internal fixation with cannulated screws should be considered as a valuable option for UFNF in the elderly population (6). Therefore, screw fixation as an important technique of internal fixation method should be considered for both young and elderly population with UFNF.

Among the wide variety of available implants for UFNF internal fixation, modern orthopedic surgery practice has chosen the usual choices of multiple cannulated screw (MCS) system or dynamic hip screw (DHS) device. This has led to a suppression of older methods such as hook pins, Knowles pins, and the Watson-Jones nail (28-30). The literature review shows that although DHS fixation requires more soft tissue dissection and larger skin incision, it is recommended to be used in elderly patients with osteoporosis due to simplicity, efficacy, and high overall



success rate (29). Although in displaced femoral neck fractures, age and activity status of the patient would have a considerable role in device choosing, to the best of our knowledge, in UFNFs, there is no unified recommendation about the exact role of these items in device selection (31-33).

Is There any Place for Primary Hemiarthroplasty or Total Hip Arthroplasty?: There are only a few experiences on performing arthroplasty for UFNFs. One of the highest levels of evidence is a randomized clinical trial on 219 cases, comparing hip joint replacement for UFNF with screw fixation by Dolatowski et al. (34) in 2019. In this multicenter study performed in Norway, hemiarthroplasty was not found to be superior to screw fixation in reestablishing hip function measured by Harris Hip Score (HHS). It should be noted that in 2016, a 5-year follow-up non-registered control trial on 78 cases in geriatric population indicated that hemiarthroplasty might provide hip functions better than screw fixation (35). However, the data validity of this study was furtherly disputed (36).

How to Perform Screw Fixation?

Pre-Operative Planning: The optimal time of femoral neck surgeries is not defined accurately. However, a meta-analysis of 52 studies with more than 290000 patients found that surgery within the 48 hours of admission resulted in a decrease in hospital stay duration, as well as complications and mortality rate. The British Orthopaedic Association Standards for Trauma (BOAST) guidelines also have recommended that surgical fixation should not be delayed more than 48 hours from admission, unless there are reversible medical conditions (28). Integrated care with the medical team especially endocrine and nutrition evaluation is essential in such cases. The surgeon must have a thorough discussion with the patient about the surgical plan and potential postoperative restrictions.

The Operation

Positioning: The patient is usually placed supine on the operating table. A fluoroscope is positioned to screen an anteroposterior (AP) and lateral radiograph of the hip, that can be facilitated by flexion and abduction of the contralateral hip. Fixation of UFNF is usually straightforward (37).

Operative Technique

The patient would be placed on a radiolucent fracture table and his fracture patterns would be confirmed via fluoroscopy before surgery is initiated. The procedure can be performed percutaneously and the surgical exposure required is minimal. If the open procedure is carried out, a short linear incision is made from inferior to the vastus lateralis ridge of the greater trochanter for about 5 cm. Guide wires can then be introduced into the femoral neck using the image intensifier for a position guide (Figure 1).

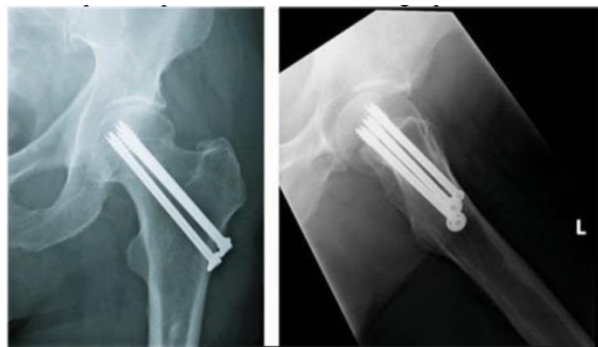


Figure 1. Intracapsular undisplaced femoral neck fracture (UFNF) fixed with three cannulated screws

The most accepted procedure consists of the insertion of three parallel cannulated screws to allow controlled compression. The optimum position of the screws is also not obvious, particularly whether they should be parallel or divergent. Zlowodzki et al. showed that outcomes of using screws with washers was more favorable than using them alone (38). For the DHS technique, the DHS is advanced centrally into the femoral head over a guide wire to a position that its trunk would be leaning against the calcar and its tip would be placed in the subchondral part of the femoral head. The screw is fixed in a two-hole plate. Technique of the Gouffon screws are also experienced in the recent literature. The Gouffon screws are introduced parallel to a guide wire; the two lower screws should be preferably with calcar support, and all three with their subchondral-placed tips form an equilateral triangle in the femoral head (39). A study by Lee et al. (40), comparing DHS and MCS in UFNF, indicated that although DHS required a larger skin incision and involved more soft tissue dissection, its use in the elderly population with osteoporosis was recommended as it was simple and efficient, and had high overall success rate. Despite this recommendation, a recent systematic review noted MCS as a valuable method for UFNF fixations (6).

Surgical Outcomes: Failure Rate and Complications

Nonunion and Secondary Displacement: Reviewing the literature, the union rate of UFNF post-screw fixation is reported with a range of 77% to 100% (29, 40). Most of the studies have reported 0% secondary displacement; however, Hui et al. (41) reported 26.7% in their octogenarian population, and Chen et al. (16) reported 5.4% in their survey.

Complications

Mortality Rate: The mortality rate reported in a recent systematic review study on internal fixation outcomes for UFNF was about 24% based on 6 evaluated studies, and one-year follow-up mortality rate was about 19% (6).

Reoperation and Conversion to Arthroplasty: Reoperation rates of 8% to 19% have been reported, that is similar to the rate of arthroplasty conversion (8%-16%). The considerable concern is reoperation in the elderly population. Hui et al. (41) indicated that octogenarians had a high rate of 31% for arthroplasty conversion, so that a suggestion for choosing another treatment for this group of patients should be considered.

AVN: The reported AVN in the literature ranges between 0% in Watson et al. (42) study to 26.7% in Hui et al. (41) study on octogenarians. This complication should be considered for further attention in high-risk patients including the elderly population.

Infection Rate: According to a recent systematic review on the outcomes of UFNFs with internal screw fixation, most of the studies have not reported the infection rate (6). However, it should be noted that a 692-case cohort study on the comparison of screw fixation in UFNFs and arthroplasty in displaced fractures was done by Parker et al. (43); it showed that there was only a 0.29% risk of superficial wound infection and 0% deep wound infection in UFNF group, while it was 3.76% and 1.45% in displaced fracture group, respectively.

The Role of Pauwels Angle in the Outcomes

The literature has mentioned that femoral neck fractures with higher Pauwels angles are more prone to healing complications (44). A recent survey on 259 cases of UFNF with cannulated screw system fixation found that there was a greater instability in fractures with a high Pauwels angle; it was found that Pauwels angle in the

group reporting failures had greater values in comparison with the successful group [$46 \pm 13^\circ$ versus $25 \pm 5^\circ$, $P < 0.001$, mean difference = 21, 95% confidence interval (CI): 18-24] (45). However, Clement et al. (46) in their cohort study on 162 cases did not find any significant relation between Pauwels classification and UFNF failure group.

Stress Fractures: Stress fractures are considered as fractures that occur with either normal stress on abnormal bone (insufficiency fracture) or abnormal stress on normal bone (fatigue fracture). Although they are common injuries in lower extremities, femoral neck stress fractures account for only less than 5% of all stress fractures, and UFNFs are much less common. Undisplaced femoral neck stress fractures (FNSFs) that are incomplete compression-side fractures are indicated to be treated non-surgically with crutch-assisted non-weight-bearing ambulation. However, incomplete compression-side fractures which have failed after non-surgical treatment for a minimum of six weeks, tension-sided incomplete fractures, or complete fractures are indicated to be treated with percutaneous screw fixation (47-49).

Conclusion

UFNFs are supposed to be treated surgically, in particular with internal fixation using screws. There are several methods for fixation by screws based on the number and direction of the screws. DHS is preferable for the base of the femoral neck fracture exactly in the elderly patients. It is so important to approach step by step to a femoral neck fracture to achieve best outcome with minimal complications.

Conflict of Interest

The authors declare no conflict of interest in this study.

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